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Gas Journal

LIGHT - HEAT - POWER - BY-PRODUCTS

Vol. 242. 95th Year. LONDON, SEPTEMBER 22, 1943. No. 4192. Price 1/-

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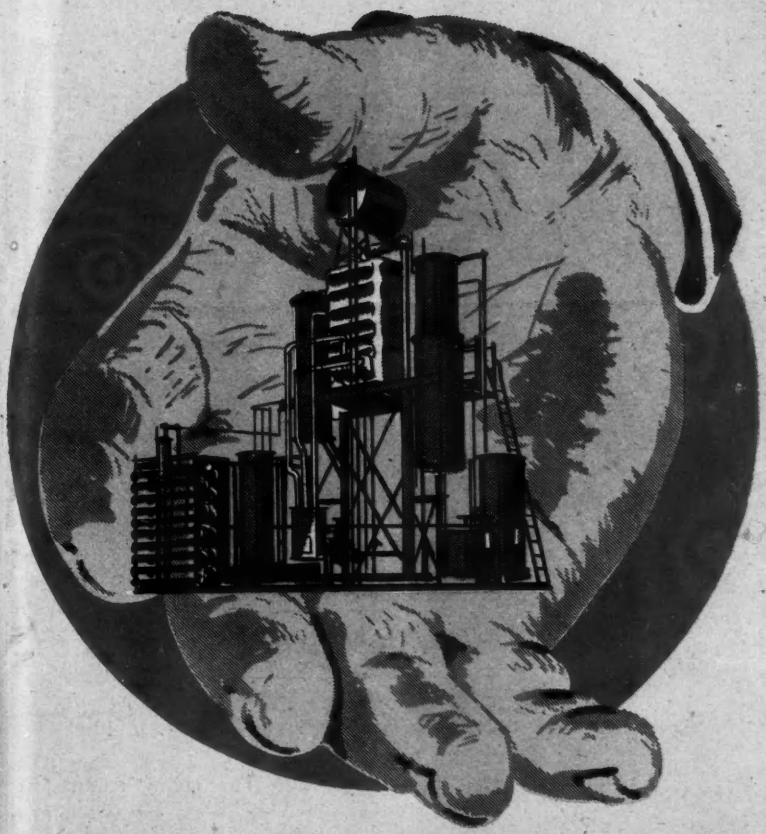

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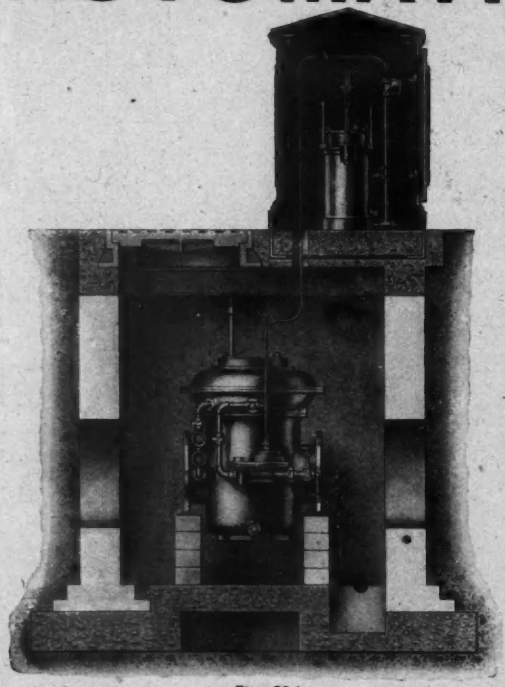

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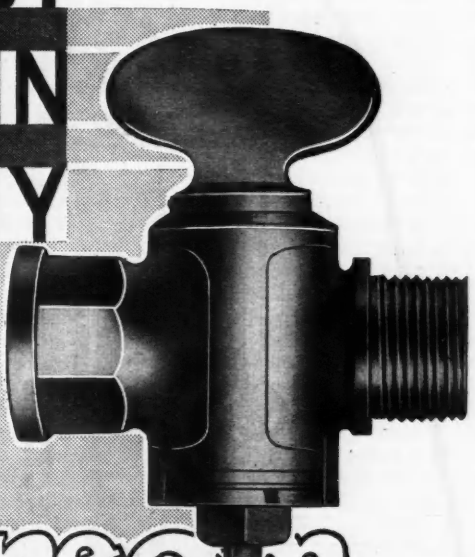

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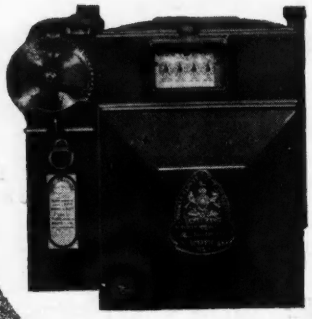

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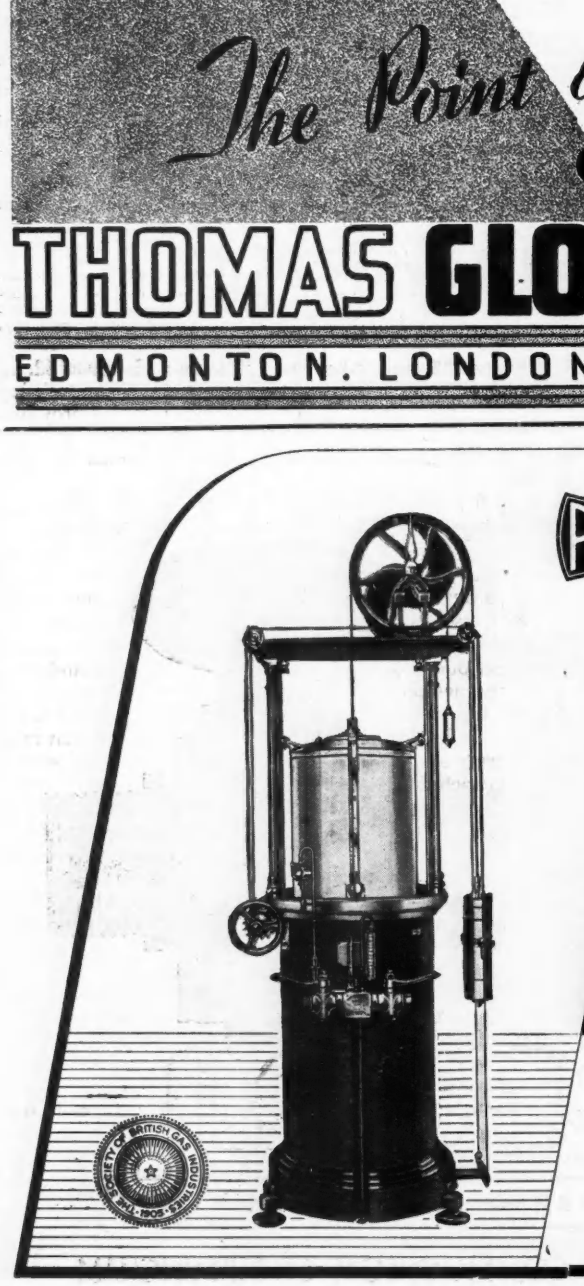

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GAS JOURNAL, SEPT. 22, 1943

VOL. 242 95th YEAR No. 4192

EDITORIAL NOTES

ROAD TAR POST-WAR

A FEW days ago we were asked whether tar would be used less or more on the highways of this country after the war—whether there would be a tendency for concrete to supersede tar. So we will briefly and quite disinterestedly examine the facts of the road tar situation, with which we may say we are well acquainted. Road making was a science rapidly developing in the immediate pre-war years, and in many directions, both in the laboratory and on the roads, work was increasing both in scope and volume on the preparation and application of tar for the purpose, and evidence was accumulating that tar was more than maintaining its position as a very important road binder. New techniques were being studied and put into practice, and we had passed the haphazard stage. Road making, as we have said, was being considered properly as a science; work was being carried out in Government and private centres and the several interests involved were being correlated. Of course, trials in the field—or, rather, on the road—take time. The qualities of the materials and technique employed, whatever assumptions are made in the laboratory, cannot be proved overnight. It takes years of use to appraise them under varied climatic and traffic conditions. But it is now, we believe, thirteen years since certain large scale road tar "trials" were launched on the Kingston By-Pass. We travel over these stretches every day in wartime and we passed over them a good deal in peacetime, when the volume of traffic was immense. During these thirteen years we have had sun, wind, rain, and winters of severity beyond the usual, as records have shown, and the tar road stretches, experimental in 1930, have withstood wear and tear in quite an astonishing way, and to-day we are not bumped about and we have no tremors about skidding.

The position of tar *vis-à-vis* imported material and concrete had in fact strengthened prior to the war, and since the outbreak of war this "strengthening" has grown, not waned. From September, 1939, onwards the confidence of Government and municipal authorities in the capabilities of tar, a home-produced commodity, for making good, durable roads has, we have good reason for knowing, become firmer. Government departments appreciate more than ever what can actually be accomplished by this material. Why should we expect that they will tend to re-embark on imported products after the war? Or why should we expect that they will concentrate solely on concrete? The advance which has been made in the construction and maintenance of roads indicates the extended use of tar after the war. This year, for example, has seen the issue of new road tar specifications of a more stringent nature than those of pre-war years, and to these new specifications we have referred in our columns. At the present time in one of London's well-known and extremely heavily trafficked central thoroughfares a trial of hot-process tarmacadam, on which high hopes are placed, is in progress, and we look forward before long to being able to give information about it which will confirm our optimistic attitude about the post-war prospects of tar for road making. Other "severity" tests are taking place.

To suggest that concrete, and concrete only, is the material *par excellence* for road construction after the war is to our mind to take a narrow view. Schemes are being put forward for new high-speed motor roads to be constructed of concrete. We have not the slightest opposition to offer against the suggestions made. It is most desirable that concrete should have its tests and trials, which obviously must take time—years of post-war usage—before the results can be rightly assessed. But these high-speed motor road schemes for concrete do not constitute a general highway plan. We are open to correction on our figures, but if we take the highways of this country which will need attention after the war as about 190,000 miles, we gain a sense of perspective of the general problem when we see that the concrete motor road schemes cover something like 1,000 miles. We do not and, indeed, have no desire to rule out the possibilities of concrete, but the road surface area in this country in relation to the tar produced is enormous—and the all-round success of the rigid concrete road remains to be proved. It seems to us that there will be development in post-war years for many thousands of miles of "flexible" roads, resilient roads able to respond over the years to impact forces, and we are confident that in this development tar will play a dominant part. We cannot agree with those who may say that the future of tar for road making is insecure. The facts and the scientific work being done on the problem appear to us to point entirely and unmistakably in the other direction.

TRAINING OF ENGINEERS

LAST week the Institution of Mechanical Engineers issued a memorandum defining its attitude towards the proposals in the White Paper on educational reconstruction presented to Parliament in July. The contents of the memorandum are of interest and importance to the Gas Industry. It suggests that among a series of permanent advisory councils there should be one to advise the President of the Board of Education on matters relating to the education and training of engineers, and it should constitute part of a permanent board for technical education. The Institution welcomes the proposed provision that facilities for full-time and part-time technical education should be obligatory on local authorities, if the intention is to confer statutory powers on the Board of Education in this respect. It also notes with satisfaction the proposal to extend local educational administration to a wider basis, covering fully the work of both technical colleges and the universities and securing their effective support.

We thoroughly agree with the Institution's insistence that there is an essential difference between the teacher of engineering—this, of course, includes gas engineering—and the teacher of school and purely academic subjects. The former is and must remain an engineer; the latter makes teaching his career, and may not be qualified for any other occupation. And we come to the question of remuneration, and the conclusion that rates in many parts of the country are far too low to attract competent part-time teachers for evening class work. Then there is the matter of equipment, and there is no doubt that the standard of equipment in use has often been deplorably low, and comparison with what can be seen in many other countries which are our keen commercial competitors, leaves little cause for satisfaction, much for apprehension, and some for envy. The method should be extended and developed whereby industrial organizations and associations can install and replace equipment for higher technical training so that it will be always up-to-date. Teachers, it is urged, should be encouraged to go back to industry occasionally for industrial refresher courses. Those engaged on advanced work should not have such heavy programmes that they have no time for research or for keeping abreast of developments in engineering practice. Exchanges of teachers should be arranged between universities and technical colleges in this country, and it would be of even greater value to arrange exchanges between the technical colleges in this country, the Dominions, the United States, and other countries. For courses for professional engineers in universities the Institution would welcome a system of State bursaries, similar to the war expedient, to assist young engineers likely to profit by them. It also strongly supports the proposal that boys who have not gone into

industry at 16 should have one year's practical work in industry before going to a university.

As the memorandum points out, up to the end of the nineteenth century, almost all professional engineers obtained their theoretical training by part-time study concurrent with their apprenticeship course. With the increasing development of university training for engineers, a large number of young men obtained the greater part, if not all, of their practical training after graduation. During the past twenty years, a few young men have secured a short period of practical training between school and university. It is recommended that all those who are able to include a full-time university course in their training as engineers should undertake a period of works training before they proceed to the university. The advantages of an organized pre-university practical training are that the boy has an opportunity of finding out what engineering is like; the experience assists in the general development of his character, and he enters the university in a more mature state; contact with engineering practice is of the greatest help in giving him an appreciation later of the significance of his theoretical studies; he is accepted by the craftsman and helped in a way that would not be possible if he were an adult.

There is also the question of post-graduate training of technical staff and executives, and facilities for this are at present inadequate. It is suggested that a post-graduate college should be established to provide courses on a full-time basis. The college should be financed mainly by the State, and should be controlled by an independent self-governing body, but might be developed by addition to one of the large existing and well-established colleges. Although the original charter of the Imperial College of Science and Technology visualized this development, it has never been carried out. Such a college, if established, could do valuable work in many fields, of which the following three might be cited as examples: It could provide courses expounding the latest advances in knowledge in single fields, such as heat transmission, combustion, elasticity, properties of materials, vibration, or the technology of specific developments in modern practice. It could provide courses in administration, organization, economics, and commerce related to the engineering industry. By constant study of the growing body of knowledge in any particular subject, it could try to bridge the gap between research practice and teaching. It could do this by putting recent developments into teaching form—no easy task in some cases—and thereby reduce the inevitable lag between research, teaching, and practice.

The memorandum as a whole, which we think is severely practical in its recommendations, links up with specific training for gas engineering; and there is a good deal to be said for the view of the Council of the Institution of Mechanical Engineers that the emergence of this country from its relatively backward position in technical education depends largely upon the initiative of administrative officials in the hierarchy of the Board of Education; and that this initiative is unlikely to be forthcoming unless some among the highest of these officials have been technically trained and are expert in the field of technical education. We may mention finally that the Institution urges that there shall be no bar to a suitable official trained in science, applied science, or technology becoming Secretary to the Board of Education.

The Coal Situation

According to the political correspondent of the *Sunday Times*, who in the issue of Sept. 19 recounts a personal interview with the Minister of Fuel and Power, Major Lloyd George is disturbed about the coal position. Production, which improved in the last quarter of last year and enabled us to meet total consumption, dropped at the beginning of this year, and the fall has become more substantial during the summer. The drop in total production is not the only serious aspect. There is a decrease in the output of "quality" coal, including gas-making coals. Hence, said the Minister, there must be every possible economy in the domestic consumption of gas. There is now a net annual labour wastage in the pits, after allowing for all intake, of 20,000. We must raise the present labour force from 703,000 to 720,000 by next May; to do that we shall need a gross labour intake of 30,000. The fuel economy campaign will very shortly be intensified Prepayment gas consumption has increased, he said, because "members of so many households are now at work, many of the women who normally run them are in the factories, and consequently there is a greater consumption of slot-meter gas for quick heating and quick meals when the family are at home from their working shifts. But this is counterbalanced by the reduced consumption of coal in their homes." Turning to the European problem, Major Lloyd George considered the occupied territories of Europe, excepting, of course, Germany. On the basis of supplying them with only 40% of their pre-war consumption we would have to supply 11,000,000 tons of coal a year if 50% of their own coal-mines can still be worked when the Germans are driven out, and 36,000,000 tons if only 25% of their own pits can be worked. That is the sort of problem that may face the United Nations before the war is over.

Stressing the need for using our coal to the best advantage by recovering by-products, the Minister said that since 1940 benzole recovery in this country has been increased by 20%. In addition to recovery at coke ovens, 95% of the gas produced at works carbonizing over 5,000 tons of coal per annum is now being treated for the extraction of benzole. Again, considerable economies have also been made by using tar in place of imported bitumen, principally for road and airfield construction and maintenance.

Major Lloyd George concluded his statement thus: "The time has gone when we can afford merely to burn coal, and allow its vast potentialities to go waste. If we use our coal resources wisely and scientifically, there is a great new field of development for coal in this country, and therefore of employment, not only for the miner but for other classes of workpeople."

Personal

By a strange oversight we omitted to mention earlier this month the further distinction conferred upon Mr. R. W. Foot by the B.B.C. on Sept. 1. It will be remembered that in the autumn of 1941 Mr. Foot was lent by the Gas Light and Coke Company to the B.B.C. as general adviser on the wartime organization. A few months later he became Joint Director-General, taking over the huge work of management. On the retirement of Sir Cecil Graves for reasons of health, Mr. Foot became sole Director-General from the beginning of this month. We make this somewhat belated, but no less congratulatory, reference to the appointment in order that it may be on permanent record in our volumes.

Obituary

With great personal regret we have to record the death in action of Lieut. T. W. Coghlin, London Irish Rifles, Publicity Officer to the British Commercial Gas Association since 1932. Before joining the Association's staff in 1931, Mr. Coghlin, who was a scholar of Balliol College, Oxford, had been leader writer on the *Cape Town News*. He joined the Territorial Army early in 1939. Mr. Coghlin, who was 37 years of age, was married to Mrs. Eileen Murphy, Director of Home Service, B.C.G.A., to whom the sympathy of many in the Gas Industry who knew them both will be extended. Mrs. Coghlin asks her friends not to send her letters of sympathy.

* * *

Official information has been received by Mr. J. R. Bradshaw, General Manager and Director of the Hartlepool Gas and Water Company, that his son, Sergt.-Pilot H. E. Bradshaw, previously reported missing from operations over enemy territory on Feb. 26, must now be presumed to have lost his life.

Letter to the Editor

Small Municipal Undertakings

Sir,—An Association known as "The Association of Smaller Municipal Gas Undertakings" has been formed under the Chairmanship of Councillor F. J. Harrison, who is the Chairman of the Newcastle-under-Lyme Gas Committee. Mr. F. G. Shaw, Gas Engineer, Buxton Corporation, is the Vice-Chairman. The first meeting of the Association was held at Manchester on Thursday, Sept. 16, when 45 Municipal Authorities were enrolled as members, and others are expected.

The object of the Association is to promote and protect the interests of smaller municipal gas undertakings in the forthcoming post-war planning scheme of the Gas Industry. A Committee has been set up consisting of two representatives from each of eight districts covering England, Scotland, and Wales.

Gas Department,
Brook Lane,
Newcastle-under-Lyme,
Sept. 18, 1943.

Yours faithfully,
F. L. Wimhurst,
Hon. Secretary.

TOLUENE AND THE GAS INDUSTRY*

By A. HEALEY, B.Sc.(Tech.), Oldham Corporation Gas Department

THE paramount importance of toluene in the present scheme of things needs no stressing and, although in the less explosive pre-war days it might have been considered uneconomic to utilize vertical retort benzole as a raw material from which to obtain toluene, to-day when large quantities of toluene derivatives are delivered free to the Continent every source must be tapped. On the cessation of hostilities, when wartime production has to be diverted to meet post-war needs, it seems probable that with many of its foreign assets liquidated, this country must be more dependent on its own material resources for the maintenance of reasonable living conditions for its inhabitants. This being so, a continued market for liquid hydrocarbons produced from coal seems assured for some time to come. With the refining plant at present on the market it does not appear to be economic for individual undertakings, excepting possibly the larger ones, to refine the crude benzole obtained from the stripping plant. As, therefore, the role of the Gas Industry lies mainly in the production of crude benzole, this Paper will be confined to that aspect of the problem, particularly in the direction of obtaining maximum efficiency from the plant installed.

Benzole extraction in the Gas Industry is carried out almost entirely by two methods, the first, the more common, utilizing oil to wash the gas, and subsequently passing the benzolized oil to a stripping plant, where the benzole is driven off by steam distillation. In the second, benzole is absorbed by activated carbon contained in a closed vessel, the vessel being taken out of the gas stream for removal of the accumulated benzole by steam. Two points might be noted—the first that while being cheaper in capital cost than the oil washing plants, there has not been available until comparatively recently an automatic active carbon plant. Labour charges have, therefore, tended to confine its use to some of the large works.† The second, that the removal of the majority of the organic sulphur compounds can easily be accomplished by this process. It seems probable in consequence, if the automatic plant proves to be reliable in operation, the present demand for sulphur-free gas will bring it into greater prominence.

This oil washing plant has been employed by the greater part of the Gas Undertakings in the United Kingdom extracting benzole. Several contractors offer plants suitable for works producing from 0.5 million cu.ft. per day and upwards, and an emergency plant which could be made by any undertaking, possessing a reasonably equipped workshop and having available sufficient skilled labour and materials, has been described in an Institution publication‡ and later in a Mines Department publication.

Total benzole output may be limited by either capacity of washer or capacity of stripping plant. The former may apply where new stripping plant has been added to an existing washer; in such cases it would be advantageous, when attempting to increase the overall efficiency of the plant, to consider first the washer. There are three main variables in the washing process—

(*a*) Rate of oil flow through the washer.
(*b*) Temperature.
(*c*) Rate of oil recirculation within the washer.

(*a*) Although in an under-designed washer the time contact between the gas and oil is not sufficient for equilibrium to be reached between the benzole vapour and benzole in solution, and although the concentration of benzole in the benzolized oil may be reduced by increasing the oil flow through the washer, an increase in benzole output can be made by this means. The reduction of benzole concentration in the oil would entail an increase in the ratio of steam used per gallon of benzole made, but where waste heat steam is available the added cost would be small.

(*b*) At lower temperature the equilibrium tends to an increase in the concentration of the benzole in the solution. It is to be noted, however, that with reduced temperature the oil viscosity increases.

Temperatures existing in the washer, therefore, should be maintained as low as possible to attain the most favourable conditions for benzole removal, but when reducing oil temperatures precautions should be taken that the increased viscosity has not caused a reduction in the rate of flow which may offset the benefit of the increased rate of absorption. It may be stated here that for efficient control it is essential that some form of flow indicator be fitted on the steam to still and oil pipe lines.

Where a rotary washer is used the temperature of gas leaving the washer should be one or two degrees lower than the temperature of the entering oil in order to prevent deposition of water, which, unless a settling tank is interposed between washer and stripping plant, will be carried forward to the latter, resulting in an increase of steam consumption for no good purpose. This condition need not in all cases be applied to the static multiform washer, in which deposited water settles to the bottom of the sumps and can be run off through the drain cocks.

(*c*) Little increase in production can be anticipated from a single tower scrubber by recirculation. Oil distribution at the top of the tower, however, should be uniform to ensure the maximum wetted area of the filling. Improvements in production can be effected by redesigned sprays.

Increase of recirculation in multiple tower scrubbers and static washers, by reducing the average concentration of the benzole in the oil film, tends to increase the rate of absorption. A similar effect is obtained by increasing the speed of rotation of the shaft in a rotary washer.

In installations where plants have been designed for benzole removal, sufficient regard may not have been given to the steam requirements for complete toluene stripping, which are more than twice those needed completely to strip the benzole from the same quantity of oil. As in such cases, however, the washer has usually been designed for benzole removal and its efficiency for toluene extraction is very high, an overall efficiency of toluene stripping up to 80 or 90% may be obtained.

The deficiency in these cases may be in condenser, still, or both. Reference to Table I shows that with higher oil temperatures the live steam required is reduced, live steam required with a still temperature of 130°C. being only 0.59 times that required at 110°C. It is apparent that by increasing the temperature of the oil entering the still, increase in efficiency of toluene removal may be obtained without further increasing the load on the condenser.

TABLE I.

Substance.	Steam ratio in lb. per gallon of oil with pressure 1-lb./sq.in. gauge. 110°C.	120°C.	130°C.
Carbon disulphide	0.264	0.222	0.181
Benzene	0.464	0.375	0.295
Toluene	1.07	0.843	0.639

The plant I am describing has been designed for benzole removal and to give a separate naphtha fraction, and is provided for this purpose with a fractionating column and dephlegmator. After operating the plant for a period to obtain the two separate fractions, it was decided that no financial gain was derived by so doing and the dephlegmator was put out of commission. When later, however, the complete stripping of toluene was attempted the condenser was found to be inadequate to deal with the increased weight of steam. In order to lighten the extra load the dephlegmator was brought back into use, sufficient cooling water being passed through it to reduce the temperature of the vapour at its outlet to approximately 86°C. The temperature of oil entering the still was increased to 135°C.

Under these conditions practically 100% toluene stripping was achieved. Any increase in the temperature at the outlet of the dephlegmator caused overloading of the condenser. A decrease resulted in flooding of the fractionating column. As, however, an "Arca" regulator was installed to regulate the flow of cooling water to the dephlegmator, it was possible to maintain a sufficiently even temperature for satisfactory working.

It has been suggested that a high pre-heat temperature may tend to cause sludging, but after twelve months there is no sign of sludge in either washer or coolers. This is dealt with more fully later.

A large part of the heat required in the stripping process is used merely in raising the temperature of the wash oil, which leaves the still at substantially the same temperature as it enters. Apart from radiation and convection losses from the walls of the pieces of plant and the sensible heat of water from steam traps, the remainder of the heat input is contained in the steam and benzole vapour leaving the top of the still.

Steam and cooling water economy is effected by passing the cold benzolized oil from the washing plant first through vapour-oil and oil-oil heat exchangers. In considering the motive power for the pumps required for the plant it should be borne in mind that exhaust steam can supply a further quota of pre-heat. Steam drives are, therefore, often to be preferred to gas or electric. When these measures have been adopted the final pre-heater is required only to raise the temperature by approximately 20°C.

Table II contains working results from the plant I am describing extracting over 3 gallons per ton of benzole.

TABLE II.

Heat exchanger.	Temperatures. In °C.	Out °C.	Temperature rise °C.	Heat input B.Th.U./hr. (calculated).	% of total heat input.
Vapour-oil ...	15	66	51	503,540	43.8
Oil-oil	66	98	32	311,260	27.2
Exhaust steam ...	98	111	13	131,320	11.5
H.P. steam ...	111	130	19	202,580	17.5
Total pre-heat				1,148,700	100%

Thus, of the total pre-heat required 71% is obtained from waste heat contained in debenzolized oil and the mixture of benzole and

* From a Paper to the Manchester and District Junior Gas Association.
† "GAS JOURNAL," 1934, **205**, 741.
‡ *Recovery of Benzole and Toluole from Gas under Emergency Conditions.* I.G.E. Publication, No. 215.

water vapour leaving the still. Exhaust steam available in excess of that required for the exhaust steam pre-heater forms a considerable proportion of the stripping steam required for the still.

Total steam consumption is 1,330 lb. per hour, which is equivalent to 42.4 lb. per gallon of benzole.

Having installed heat exchangers to recover the available heat from vapours leaving the still and from debenzolized oil, the quantity of heat to be dealt with by cooling water remains high, and if town supply were to be bought through a meter it would place a heavy charge against the process. It is usually in such circumstances advantageous to provide some other source of supply.

Borehole water where available is cheap, and has the advantage of retaining a lower temperature during spells of warm weather than does surface water. In limestone districts, wells often provide a water high in temporary hardness which will rapidly scale over the condenser and dephlegmator tubes, thereby reducing their efficiency and incurring regular charges for cleaning and stoppage of plant.

On the plant described no well water was available and it was decided to install a circulating system.

The incidence of sludge in the wash oil affects the efficiency of the plant in a variety of ways. The solids forming the sludge are in general more soluble in hot oil than in cold, and tend to settle, therefore, at points in or after the coolers.

In rack coolers the lining of the tubes with deposited solids reduces the rate of heat transfer, and may result in an increase in the temperature of oil returned to the washer. Deposits in pipe lines reduce the effective cross-sectional area of the pipes and may lead to increased pumping charges. If sludge reaches the washer, filling the interstices between the packing material, it may increase the back pressure thrown on the exhauster, and at the same time reduce the efficiency of the washer by reducing the surface area of oil presented to the gas.

There does not appear to be, in any instance where sludge has been encountered, a proof of the cause of formation. A number of feasible theories have been advanced, however, which may offer some indication of the pitfalls to be avoided. The more probable of these theories are:

(*a*) Unsaturated hydrocarbons washed from the gas may, by repeated heating and cooling during the stripping and washing cycle, polymerize to form complex molecules.

(*b*) Some cracking of the oil may take place in the preheaters and the resulting unsaturated hydrocarbons polymerize as in (*a*).

(*c*) G. A. Dummett, in a contribution* to a Paper by G. J. Greenfield, suggested that even at the extremely low vapour pressures obtaining, small quantities of high boiling polyhydric phenols may be carried forward to the washer and accumulate in the oil, eventually being deposited as sludge. A similar result may be obtained where the purifying plant is inadequate and permits tar fog to be carried into the washer.

(*d*) Polymerization of aromatics and unsaturated hydrocarbons may give rise to complex heterocyclic aromatics insoluble in mineral oil.

Some support for these theories is obtained from observations made, showing that while creosote when used as a washing medium becomes progressively thicker before depositing a sludge, the viscosity of mineral oil composed mainly of paraffin rises rapidly and more quickly precipitates solids. Certain precautions suggest themselves as follows:

(*a*) and (*d*) Complete removal in the stripping plant of all constituents washed from the gas at every cycle would prevent polymerization due to repeated heating and cooling.

(*b*) The use of well-refined mineral wash oil may be effective in preventing any cracking and, as has been stated previously, no sludge trouble has yet been encountered in the plant described using pre-heat temperatures up to 135°C. The wash oil used has been Shell benzole wash oil.

(*c*) Adequate purifying plant will reduce the possibility of impurity being carried forward in the gas either as vapour or suspension.

A further possibility which should not be overlooked is that where the wash oil in the still is exposed to exhaust steam, lubricating oil from pumps or engines may be absorbed into it. In order to obviate trouble from this direction a good quality straight mineral cylinder oil has been used on the two Sisson engines exhausting to the stripping plant.

Efficiency

Silver and Hopton† have shown that fairly close approximations of the efficiency of plants with ample capacity can be calculated from data recently obtainable, but for reliable information on the overall efficiency of the plant tests should be carried out on the gas at the inlet and outlet of the washer. Of the two methods most used to remove the benzole from the gas, the modified St. Claire Deville method is to be preferred from consideration of both accuracy and simplicity of operation.

For routine determinations of toluene content a fractionating apparatus incorporating a simple form of jacketed Dufton column and a pocket refractometer is obtainable from Messrs. Townson & Mercer, Ltd., and other scientific instrument makers. The sample is fractionated in the Dufton column, and the fraction distilling between 95°C. and 125°C., which contains all the toluene, is collected separately for subsequent examination by means of the refractometer. Tables prepared by the Government laboratory correlate the percentage of toluene with the refractive index of the liquid.

An accurate estimation of the performance of stripping plants can be made by fractionating samples of benzolized and debenzolized oils in the fractionating apparatus, and the examination of the 95°C. to 125°C. fraction by the refractometer.

TABLE III.

Test on debenzolized oil. Still temperature °C.	Steam/oil ratio lb./gall.	% Toluene in debenzolized oil.
121	0.97	0.01
125	0.87	0.004
128	0.78	0.005
Hollinwood plant:		
100	0.92	0.182
110	1.07	0.033
120	0.82	0.026

Table III illustrates the benefit obtained from increased pre-heat. In both plants it was found that increased pre-heat gave increased stripping efficiency with a reduction in steam to still.

TABLE IV.

Benzole, gallons per ton	...	...	0.95	1.6	3.0
Sulphur, grains/100 cu.ft.	...	...	25.1	23.0	21.1

Table IV illustrates the reduction of sulphur in gas which has followed increasing benzole production. While the reduction obtained has not been so great as had been anticipated, the position is somewhat obscured by the fact that progressive increases in benzole production have been made during the war period when there has been some deterioration in coal cleaning. While, therefore, no conclusions can be drawn as to the quantitative reduction in organic sulphur compounds in gas due to increased benzole production, it is apparent that a definite reduction has been achieved. Although it would be difficult to assess the cash value of the benefit derived it will not be contested that a gas with a low sulphur content is desirable, and some credit us due to the benzole plant on that account.

Further improvement in sulphur removal will be obtained, when demands for toluene have diminished by an increase in the rate of oil flow through the plant accompanied by a reduction in the steam oil ratio to the still.

Calorific Value

The reduction in calorific value of the gas consequent on benzole removal may be compensated by one or more of the several methods stated.

(*a*) By a reduction of declared C.V.

(*b*) By increase of C.V. of the gas leaving the retort house.

(*c*) Where diluent gas is added to reduce the C.V. of coal gas the proportion of diluent gas may be reduced.

(*d*) An increase may be made in the quantity of oil cracked in water gas plant where this is normally employed.

The choice of method employed by any undertaking must be determined largely by local conditions. Factors to be taken into consideration include capacity of storage and mains, type of gas-making plant, and the state of the coke and by-products markets. In my undertaking storage capacity was sufficient to meet present needs and, in all except one area, mains were known to be of ample size to accommodate the increased volume of gas required at a reduced C.V. The carbonizing plant consists entirely of vertical retorts designed for production of gas at 475 B.Th.U./cu.ft., which was the declared calorific value when increased benzole stripping commenced.

It had been anticipated that the reduction in steam to retorts necessary to increase the C.V. of gas entering the benzole plant to 495/500 B.Th.U./cu.ft. might cause some heating of the bottom ironwork. This anticipation was realized in fact.

Since 1939 there has been an increase in the number of coke oven plants in operation, and there is likely to result, post-war, keen competition from this source in the markets normally supplied by the Gas Industry.

These were the balancing factors in the decision made to reduce declared C.V. to 450 B.Th.U./cu.ft.

No difficulties have been encountered in distribution, nor have any complaints been made of reduction in efficiency of any of the appliances in the area.

Discussion

Mr. **R. Walker** (Manchester) emphasized the importance of maintaining the correct temperature and condition of the stripping oil, and suggested that consideration should be given to the coke-oven practice of continuous re-conditioning by re-distilling and blending. The method of circulating oil to the respective bays of the washer was also important. In cases where there should be an independent supply of oil to the various bays of the washer this was not always taking place, particularly when multi-pumps were in use.

Mr. **Healey,** in reply, said that he had not found it necessary to arrange for the regeneration of the wash oil. Viscosity tests on oil which had been in use for twelve months indicated very little change from the original oil.

Mr. **H. C. Applebee** (Manchester) said that he had experienced no

* *Gas World*, October 3, 1942, p. 14.
† *J.S.C.I.*, **62**, 37.

serious difficulty with sludging when using creosote oil, gas oil, or specially-prepared oils for benzole washing. The oil should be kept clean, or heavy emulsions might be formed. Coke dust might form a nucleus around which there might be emulsification. The temperature of the oil should be above 100°C., for if it were near the 100°C. mark there might be condensation of steam vapour trapped in the oil. This would tend to form an emulsion if not a definite sludge.

The Paper stated that approximately 15% of the total potential crude benzole yield was composed of low-boiling liquids and its extraction from the gas might not serve any useful purpose except the removal of sulphur. The reduction of the sulphur content in the gas was highly desirable, but the refiners of the crude benzole were not quite so certain as to the advantage of rectifying a spirit containing so high a proportion of sulphur. The solution to the problem could not yet be foreseen, but it would have to be faced in the post-war period, particularly, as Mr. Healey suggested, if further washing had the effect of bringing out still more sulphur compounds with the deliberate intention of reducing the sulphur content of the gas.

A statement made in the Paper was that in the case of installations where the plants had been designed for benzole removal, sufficient regard might not have been given to the steam requirement for complete toluene stripping, which was more than twice that required to strip completely the benzole from the same quantity of oil. As the washer had usually been designed for benzole removal, and as its efficiency for toluene extraction was very high, an overall efficiency of toluene stripping up to 80% or 90% might be obtained. It was necessary to bear in mind that as there was a reduction of the oil flow through the washer in relation to the gas passing through, the relative amount of toluene extraction was increased—*i.e.*, not the absolute amount, but the relative amount.

The Author had stated "Of the two methods most used to remove the benzole from the gas, the modified St. Claire-Deville method is to be preferred from consideration both of accuracy and simplicity of operation." He would have agreed with that statement a few weeks ago, had he not since seen figures produced which seemed fantastic and not at all comparable with the results achieved on the plant. Was there some hidden factor or some factor for which sufficient account was not taken in the making of the test?

Mr. **Healey,** in reply, said a benzole plant should not be regarded as a sulphur-extraction plant. A separate plant should be erected, unless a method of refining was forthcoming which would be less costly in dealing with benzoles having a high sulphur content.

Mr. **J. A. Speers** (Preston) asked what was generally considered to be a high pre-heat temperature. The temperature mentioned in the Paper was from 110° to 115°C. If the quantity of static oil in the still were reduced—*i.e.*, after it had come down and made contact with the steam—then less steam would be used. At Preston the temperature for the still was something over 130° and left the still at 115° to 120°. The difference was apparently due to the quantity of oil. He thought there was approximately 18 in. to 20 in. of oil remaining in the bottom of the still. What was the steam/oil ratio? Had Mr. Healey occasionally to get the return oil up to 78° to 80° for safety, or was he able to keep down to an ideal extraction figure, which he thought should not exceed 60°.

Mr. **Healey,** replying, said the average still temperature was given at the inlet and outlet of the still. He always regarded 130° to 135° as being reasonably high. If the steam/oil ratio could not be obtained by increasing the steam, it could always be obtained by reducing the oil. He agreed that a temperature of 75° in the washer was rather high.

Mr. **W. Hodkinson** (U.K.) enquired the result of the redeclaration of calorific value at Oldham. In the coke-oven industry many of those companies which were selling gas to local undertakings had changed over from creosote to gas oil for benzole extraction. Pre-war very little trouble was experienced, but sludge occurred. At the present time, with one exception, coke-oven plants were experiencing very severe trouble, due possibly to the poor quality of gas oil that was available. Stripping was taking place to a high degree, possibly 94 to 96%, taking out 4 to 4½ gallons per ton. A well-known Motor Car Company claimed that no trouble was being experienced with sludge, although gas oils were being used. It was claimed that the freedom from sludge was entirely due to the use of low pre-heat temperatures. In his experience with temperatures of 70° to 75° on the benzole washer, a really efficient extraction could not be achieved.

Mr. **Healey** said there had not been an increase in the cubic feet of gas sold corresponding to the reduction in calorific value. This implied an increased efficiency in the use of gas and, although it had the effect of temporarily reducing income from gas sales, it should be an advantage, taking the long view. With regard to the realiability of the St. Claire-Deville method, as used in the coke ovens where there were more than 4½ gallons per ton, he wondered whether they were using one receiver or two receivers in series. If only one were used, then two in series might prove more reliable. Increased accuracy might be obtained by reducing the rate of gas flow through the apparatus.

Mr. **A. K. Howell** (Manchester) remarked that since an activated-carbon plant had been put in they had never been able to get the same results with the St. Claire-Deville tests. The tests had invariably been the lower.

Mr. **H. V. Dann** (Blackburn) moved, and Mr. **W. Hodkinson** seconded, a vote of thanks to Mr. Healey for his Paper.

MOTOR BENZOLE*

By W. A. BRIGGS

WITH the introduction of the manufacture of the fine chemicals such as dyes, drugs, explosives, perfumes, solvents, &c., a demand was created for the aromatic hydrocarbons, benzene, toluene, and xylene. The chief source of these hydrocarbons was from crude benzole extracted from coke oven gas and coal tar. It was not until the last war, when benzene and toluene were required for the manufacture of explosives, that gas companies of reasonable size extracted crude benzole from coal gas, and after the war many companies ceased to manufacture crude benzole.

Benzole for use as a motor fuel was first suggested in 1907, but it was not until after the last war that the fuel was used on a commercial scale; the distribution and marketing of the fuel was chiefly done by the National Benzole Company. Benzole as used as a motor fuel is a mixture of benzene, toluene, and xylene, with varying percentages of hydrocarbons of the aliphatic series depending on the type of plant in which the coal is carbonized.

The quantity of benzole used as a fuel increased from 27 million gallons in 1907 to 61 million in 1937, and since the outbreak of the present war there has been a big increase in the manufacture of crude benzole.

The following analyses show the approximate composition of crude benzole as produced from the various types of carbonizing plant:

(A) Horizontal retorts, using gas oil.
(B) Continuous vertical retorts.
(C) Carburetted water gas.
(D) Horizontal retorts, using active carbon.

	A.	B.	C.	D.
Thiophene and Carbon Disulphide	0.80%	0.40%	0.01%	1.0%
Benzene	61.20%	30.10%	30.40%	60.4%
Toluene	12.00%	9.20%	22.20%	14.9%
Xylene	3.00%	6.00%	3.60%	3.3%
Paraffins	4.10%	20.00%	5.40%	2.4%
Loss in Washing: ...	13.7%	21.00%	—	14.4%
(*a*) Olefines	9.1%	—	13.00%	10.4%
(*b*) Dienes and Gum-forming Compounds	4.6%	—	19.00%	4.0%
Oil above 140° ...	4.40%	13.30%	6.39%	3.50%
Specific Gravity ...	0.873	0.833	—	0.880

Valuation of Crude Benzole

Prior to 1938 the price of crude benzole was calculated from an analysis done by a retort test. The test was carried out by distilling 100 ml. of the crude benzole in a retort fitted with a thermometer, the bulb of the thermometer being ¼ in. off the bottom of the retort. The amount of distillate to 120°C. was taken as the basis for the valuation of the crude benzole. A standard price was chargeable for crude benzoles testing 65% at 120°C., with allowances for those testing above or below this figure.

There was no standard method of operation for this test, and I have heard of some analysts who used to add the "distillation loss" on to the yield at 120°C.

This method was unsatisfactory, as the percentage yield up to 120°C. did not give an accurate or consistent figure of the yield of motor benzole obtainable from a crude benzole. No allowance was made for the sulphur content, which has a large effect on the valuation of crude benzole, high sulphur content, giving reduced yields and increased costs because more drastic washing is necessary to bring the sulphur down to the specification limit.

A Committee was set up for the purpose of valuing crude benzoles; much valuable work was done, and a suitable scheme evolved to enable the value of a particular crude benzole to be ascertained. The principles of the scheme are based on average works practice, and the crude benzole is valued on the percentage yield of motor benzole at motor benzole price, plus the percentage yield of creosote at creosote price, less an allowance for working costs and profits, calculated on the "once-run benzole" content. The ascertained sulphur content of the crude benzole places it in a particular grade, each grade having different allowances for working costs.

A method of testing crude benzole was standardized. The "once run benzole" content is ascertained by the distillation of 100 ml. of the sample through an eight-bulb fractionation column of standard size, fitted with a standard thermometer and condenser. The distillation is carried out at a definite speed and the amount of distillate to 160°C. taken as the "once-run content," the residue being taken as creosote.

(*Note.*—To the 100 ml. crude benzole for testing 20.0 ml. of creosote previously fractionated up to 195°C. are added to ensure that there is sufficient liquid in flask at the end of the distillation.)

The sulphur content of the "once-run content" is determined by a standard method, the percentage sulphur present fixing the grade in which the crude benzole is placed.

* From a Paper to the Auxiliary Section of the North of England Gas Managers' Association, May 28, 1943.

Grade A 0 .. 0.5% Sulphur.
„ B 0.5 .. 0.75% „
„ C 0.75 .. 1.0% „
„ D 1.0 .. 1.5% „

The percentage yield of motor benzole obtainable from each of these grades has been calculated to be:

Grade A .. 95% of once-run content.
„ B .. 94% „ „
„ C .. 92% „ „
„ D .. 89% „ „

An allowance for working costs and profit for each of these groups has been allotted. The price of the crude benzole is then calculated from the yield of motor benzole and creosote at an ascertained price.

Refining of Motor Benzole

The main consideration in the refining of motor benzole is to ensure a final product that can be used in an internal combustion engine. The fuel must be of such quality that it does not contain any gum-forming compounds, it must be free from corrosive compounds, it must be low in sulphur, the colour and odour must be good, discoloration may not have any detrimental effect, but the marketing value of a water white fuel is of great importance.

Prior to the introduction of the inhibitor process of the National Benzole Company in 1933, the above requirements were easily obtained by washing the crude benzole with strong sulphuric acid (R.O.V. 98% H_2SO_4), and the method is still used for the treatment of benzoles containing a high percentage of thiophene and also in the manufacture of pure benzene, toluene, and xylene. Sufficient strong acid was used to ensure that the finished product passed the National Benzole Company's "acid wash test."

The washing of crude benzole by strong acid is a wasteful process, as many of the hydrocarbons removed by the acid have a high value as motor fuel, some of them because of their "anti-knock" value. Losses also occurred by benzole being dissolved in the acid. The steam distillation of the waste acid showed that it contained 10% of recoverable hydrocarbons. There are some plants in use for the recovery of the dissolved benzole, and also patents exist for the manufacture of coumarone resins for varnishes from the acid tar.

With the introduction of the inhibitor process by the National Benzole Company in 1933, the strong acid has been dispensed with and the gum-forming compounds stabilized by the addition of an inhibitor such as cresol, catechol, &c. In this process the once-run crude benzole is treated with—

1. 5% of 10% caustic soda.
2. Water washes.
3. 0.75% of B.O.V. (77% H_2SO_4).
4. Water washes and caustic wash.
5. Treatment for the removal of sulphur if required.

The washed crude benzole is then distilled to a point so that the distillate is within the National Benzole Company's Specification range (not less than 60% at 100°C. and not less than 95% at 150°C.).

As soon as the distillation is finished the inhibitor is added. The chemical usually used these days is "Nonocel" (catechol dissolved in methanol). Experiments done in the laboratory show that on the distillation of a washed crude benzole through a 12 bulb column up to 160°C., the distillate had an oxidation test of 232 mg. of gum per 100 c.c., but with the addition of 0.03% of catechol, the oxidation test was reduced to ¾ mg.

With the inhibitor process there is an increased yield of motor benzole, and acid costs are reduced by 75%. The thick "acid tar" is avoided, and the weak waste acid can be used for the extraction of pyridine from light oil, &c.

Tests were done on samples of crude benzole for horizontal and vertical retorts. The distillation range of the horizontal benzole was:

70% at 100°C.
88% at 160°C.

and that of the vertical:

65% at 100°C.
93% at 160°C.

The crude benzoles were washed with:

(*a*) 1.5% B.O.V. and 2.0% R.O.V.
(*b*) 5% of 10% NaOH, 0.75% B.O.V. and treatment for removal of CS_2.

	Horizontal.		Vertical.	
	a.	*b.*	*a.*	*b.*
Loss in washing	4.0%	0.8%	7.0%	0.75%
Yield of motor benzole 160°C. ...	76.0%	82.0%	78.0%	87.00%
Creosote residue and naphtha	20.0%	17.2%	15.0%	12.25%

From the above results it can be seen that the increased yield of motor benzole is appreciable, the increase being much greater with vertical retort benzoles, and it can be said that the inhibitor process has done much to encourage the extraction of crude benzole from vertical gas.

With the omission of the strong acid no reduction in the sulphur content has been effected, and in many cases the crude benzole has to be treated chemically to reduce the sulphur content.

The two chief methods are the methanol soda process of the National Benzole Company and the polysulphide process of the Yorkshire Tar Distillers. In the polysulphide process the crude benzole is treated with a mixture of ammonium disulphide, ammonium sulphide, and ammonium hydrate.

$(NH_4)_2 S_2 + CS_2 \longrightarrow (NH_4)_2 CS_4$ (Amm. perthiocarbonate)
$(NH_4)_2 S + CS_2 \longrightarrow (NH_4)_2 CS_3$ (Amm. thiocarbonate).

The spent solution is then sent back to the suppliers, who regenerate the reagent. The methanol soda process consists of the treatment of the crude benzole with methanol (methyl alcohol) and caustic soda.

$$CH_3 OH + Na OH + CS_2 \longrightarrow Na SCSO CH_3$$

At the by-product works of the Newcastle and Gateshead Gas Company the methanol soda process is used.

The mixed crude benzole from the various works has a total sulphur content of 0.7%, of which 0.38% is sulphur as thiophene and 0.42% sulphur as carbon disulphide. Experimental work showed that to reduce the sulphur to that allowed by the National Benzole Company, 25 gall. of methanol and 100 lb. of flake caustic had to be used for each charge of 2,500 gall. crude benzole.

To the charge of crude benzole in the washer after the light acid treatment, 25 gall. of methanol and 100 lb. flake caustic are added, the washer then agitated for 6–8 hours. 100 gall. of water is then added and agitated for a further ½ hour. The xanthate solution is then run off to a receiver. Two successive washes of 50 gall. are then given and the washings added to the xanthate solution. The crude benzole is then distilled as usual. No material benefit was found by heating the benzole up to 100°F. during the treatment with methanol soda, but it was found in cold weather the reaction was retarded, and that the slight warming of the charge to 80°F. was very helpful.

Methanol of a suitable quality is recoverable from the xanthate. The process is, however, accompanied by such vile odours that it is impracticable to work.

The treatment of the xanthate solution may be carried out in an airtight lead-lined washer, fitted with an agitator and vent pipe leading to an oxide purifier for the removal of hydrogen sulphide from the gases evolved during the process.

A charge of xanthate is charged to the washer and sufficient sulphuric acid (diluted to 20% H_2SO_4) is run in to acidify the solution. After the reaction is completed the mixture is made just alkaline with caustic soda to remove hydrogen sulphide. The carbon disulphide is allowed to settle out, then run off from the bottom.

The neutralized solution, which contains about 15% methanol, is now fractionated. Methanol containing 95–98% methyl alcohol is easily obtained in one distillation, with only a small percentage of weak methanol for re-distillation.

The column used is 18 ft. high by 12 in. diameter filled with 1 in. Lessing ring. Dephlegmating and main condenser are provided and storage tanks for the strong and weak methanol.

Control of working is very easy, the percentage methanol in the distillate being calculated from the specific gravity.

The crude carbon disulphide obtained consists essentially of carbon disulphide and free sulphur, about 85% CS_2 being present. It is a black, evil-smelling liquid with a specific gravity of 1.30. In the laboratory a good quality of carbon disulphide was made by washing the crude carbon disulphide with strong sulphuric acid and caustic soda, then fractionating the washed product.

The removal of carbon disulphide from benzole by some chemical means is a matter of importance, particularly in view of the present tendency towards lower final sulphur content of coal gas. More or less complete extraction of benzole from the gas affords a convenient means of extracting more sulphur. This sulphur appears in the benzole as carbon disulphide, which, while not welcomed by the refiner, can be dealt with by the methods outlined above.

Thousands of gas consumers in Cork will benefit to the amount of £24,838 which is being returned to them by way of a rebate on the price of gas for the half-year ending June 30 last. A dividend of 6% per annum has been provided for. The balance of profit and loss after providing £2,000 for depreciation is £27,579. The Company's favourable position is due to money saved on direct shipments of coal. Frequently in the past coal had to be imported through Dublin, and this extra outlay raised the price of gas to consumers by almost 50%.

Perfecta Gas Thermostats, Ltd., have changed their name to Perfecta Gas Appliances, Ltd., and have removed to larger premises to cope with increased production requirements. They are now at 31–35, Belle Vue Road, Hendon, N.W. 4. (Telephone: Hendon 3810.)

Promoted by the Staff of Galashiels Gas Company, Ltd., a show and sale of garden produce has resulted in the substantial figure of £332 being raised for the Red Cross funds.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in the "Journal" should not be taken as an indication that they are necessarily available for export.

RECONSTRUCTION OF A SMALL GAS UNDERTAKING*

By DARRELL W. REES, M.B.E.

THIS is the story of a gas-works which, at the outbreak of war, had an output of approximately 70 million cu.ft. per annum. A policy of reconstruction had to be embarked upon, as the gas output in the winter months had increased from about 250,000 cu.ft. to 350,000 cu.ft. per day, due to increases in domestic sales, and also to a large consumption under contract at a certain premises. This consumption was as much as 100,000 cu.ft. per day.

The carbonizing plant comprised one bed of six 33 in. Glover-West continuous vertical retorts, together with four beds of six, and one bed of eight 9 ft. 6 in. long, 22 in. by 16 in. stop end horizontal C shaped retorts, with no mechanical charging arrangement. The condition of the vertical retorts was not good, as apart from the resett of two of the retorts in 1937, the remainder of them had not been et for some five or six years, and were badly "holed" in places. l. gard to the horizontal retorts, these were about 40 years old, a. had received very little attention since the Glover-West retorts ere installed in 1925, and their condition was not conducive to efi ent gas making.

It was evident that it was of primary importance to increase the carbonizing plant, and as the gas output of the Company was fairly constant, and there was a ready coke sale, and having regard also to the present day high cost of gas oil, the idea of installing a carburetted water gas plant was ruled out. I brought out a specification for the construction of a setting of vertical retorts to give an output of not less than 350,000 cu.ft. per day of 450 B.Th.U. per cu.ft. gas, when using best quality washed nut gas coal.

The new retort house was to be built on the site of the existing horizontal retorts, and the existing walls of the retort house were to be re-used where practicable. The new setting of vertical retorts was to be complete with coal handling plant, which was to be constructed to feed the existing Glover-West vertical setting, together with the new setting.

On receipt of tenders for this plant, I found that, owing to wartime conditions, costs were exceedingly high, and the period required for erection was very long, as there was difficulty in obtaining materials. I then learned that there was in Scotland a vertical retort setting of four downwardly heated fireclay vertical retorts, which was constructed in 1928, and had worked up until 1934, at which time the undertaking was absorbed by a larger concern, with the result that the plant became redundant. The plant, as it stood, was suitable for rebuilding, except that the refractory material could not be re-used, but the house and setting steel work were in very good condition. Having in mind the shortage of steel work and the difficulty in obtaining same owing to war conditions, my Directors decided to purchase this setting and rebuild it.

This decision considerably eased the situation as far as the steelwork was concerned, and it was only necessary to obtain a Board of Trade permit for 120 tons of steel and cast iron to effect the necessary modifications to bring the plant in line with modern practice. The setting, when erected, was to comprise four 49⅜ in. upwardly heated silica retorts, with high level external producers.

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Owing to the shortage of steam-raising plant, it had been the policy of this undertaking to install gas engines where necessary—for example, for driving exhauster, lift, and rotary scrubber—and although the new waste heat boiler was a great improvement over the existing one, it was not of sufficient capacity to allow surplus steam to run a 30 kw. compound steam engine driven electric generating set, which I proposed to install.

The existing steam-raising plant consisted of two Cochran vertical boilers, 5 ft. diameter, 11 ft. 9 in. high, which were laid down, one in the year 1912 and the other 1914, and also a West-Galloway water tube waste heat boiler, which was put down in 1925. The general condition of these three boilers was bad, the two Cochran boilers being only for insurance up to fit 60 lb. per sq.in. This was mainly due to the fact that they had operated on untreated water, which had a temporary hardness of 17.9 degrees, and a permanent hardness of 2.06 degrees, making a total hardness of 19.96 degrees, due mainly to a high calcium carbonate content.

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As it was decided to adopt electric drive for most of the larger ancillary plant in the works, such as the coal-handling plant, lift, &c., it was now necessary to install a system of electrical generation, and as I now had an abundant supply of steam, the obvious choice was a steam-engine driven generating set. The type of plant chosen was a Belliss & Morcom compound steam engine, running at 650 r.p.m. direct coupled to a 30 kw. continuous generator at 220 volts.

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Some idea of how difficult an operation this was to carry out may be gained from the fact that in a morning the amount of gas sent out sometimes reached the high figure of 160,000 cu.ft., while at night it dropped down to as low as 30,000 cu.ft.

A high standard of efficiency had to be maintained to continue supplies under these adverse conditions, and it was necessary to make sure that all plant, such as exhausters and extractor machinery, was maintained in first-class order, as a breakdown would have meant

* Presidential Address to the Wales and Monmouthshire Junior Gas Association.

Grade A 0 .. 0.5% Sulphur.
„ B 0.5 .. 0.75% „
„ C 0.75 .. 1.0% „
„ D 1.0 .. 1.5% „

The percentage yield of motor benzole obtainable from each of these grades has been calculated to be:

Grade A .. 95% of once-run content.
„ B .. 94% „ „
„ C .. 92% „ „
„ D .. 89% „ „

An allowance for working costs and profit for each of these groups has been allotted. The price of the crude benzole is then calculated from the yield of motor benzole and creosote at an ascertained price.

Refining of Motor Benzole

The main consideration in the refining of motor benzole is to ensure a final product that can be used in an internal combustion engine. The fuel must be of such quality that it does not contain any gum-forming compounds, it must be free from corrosive compounds, it must be low in sulphur, the colour and odour must be good, discoloration may not have any detrimental effect, but the marketing value of a water white fuel is of great importance.

Prior to the introduction of the inhibitor process of the National Benzole Company in 1933, the above requirements were easily obtained by washing the crude benzole with strong sulphuric acid (R.O.V. 98% H_2SO_4), and the method is still used for the treatment of benzoles containing a high percentage of thiophene and also in the manufacture of pure benzene, toluene, and xylene. Sufficient strong acid was used to ensure that the finished product passed the National Benzole Company's "acid wash test."

The washing of crude benzole by strong acid is a wasteful process, as many of the hydrocarbons removed by the acid have a high value as motor fuel, some of them because of their "anti-knock" value. Losses also occurred by benzole being dissolved in the acid. The steam distillation of the waste acid showed that it contained 10% of recoverable hydrocarbons. There are some plants in use for the recovery of the dissolved benzole, and also patents exist for the manufacture of coumarone resins for varnishes from the acid tar.

With the introduction of the inhibitor process by the National Benzole Company in 1933, the strong acid has been dispensed with and the gum-forming compounds stabilized by the addition of an inhibitor such as cresol, catechol, &c. In this process the once-run crude benzole is treated with—

1. 5% of 10% caustic soda.
2. Water washes.
3. 0.75% of B.O.V. (77% H_2SO_4).
4. Water washes and caustic wash.
5. Treatment for the removal of sulphur if required.

The washed crude benzole is then distilled to a point so that the distillate is within the National Benzole Company's Specification range (not less than 60% at 100°C. and not less than 95% at 150°C.).

As soon as the distillation is finished the inhibitor is added. The chemical usually used these days is "Nonocel" (catechol dissolved in methanol). Experiments done in the laboratory show that on the distillation of a washed crude benzole through a 12 bulb column up to 160°C., the distillate had an oxidation test of 232 mg. of gum per 100 c.c., but with the addition of 0.03% of catechol, the oxidation test was reduced to ¾ mg.

With the inhibitor process there is an increased yield of motor benzole, and acid costs are reduced by 75%. The thick "acid tar" is avoided, and the weak waste acid can be used for the extraction of pyridine from light oil, &c.

Tests were done on samples of crude benzole for horizontal and vertical retorts. The distillation range of the horizontal benzole was:

70% at 100°C.
88% at 160°C.

and that of the vertical:

65% at 100°C.
93% at 160°C.

The crude benzoles were washed with:

(*a*) 1.5% B.O.V. and 2.0% R.O.V.
(*b*) 5% of 10% NaOH, 0.75% B.O.V. and treatment for removal of CS_2.

	Horizontal.		Vertical.	
	a.	*b.*	*a.*	*b.*
Loss in washing	4.0%	0.8%	7.0%	0.75%
Yield of motor benzole 160°C. ...	76.0%	82.0%	78.0%	87.00%
Creosote residue and naphtha	20.0%	17.2%	15.0%	12.25%

From the above results it can be seen that the increased yield of motor benzole is appreciable, the increase being much greater with vertical retort benzoles, and it can be said that the inhibitor process has done much to encourage the extraction of crude benzole from vertical gas.

With the omission of the strong acid no reduction in the sulphur content has been effected, and in many cases the crude benzole has to be treated chemically to reduce the sulphur content.

The two chief methods are the methanol soda process of the National Benzole Company and the polysulphide process of the Yorkshire Tar Distillers. In the polysulphide process the crude benzole is treated with a mixture of ammonium disulphide, ammonium sulphide, and ammonium hydrate.

$(NH_4)_2 S_2 + CS_2 \longrightarrow (NH_4)_2 CS_4$ (Amm. perthiocarbonate)
$(NH_4)_2 S + CS_2 \longrightarrow (NH_4)_2 CS_3$ (Amm. thiocarbonate).

The spent solution is then sent back to the suppliers, who regenerate the reagent. The methanol soda process consists of the treatment of the crude benzole with methanol (methyl alcohol) and caustic soda.

$$CH_3 OH + Na OH + CS_2 \longrightarrow Na SCSO CH_3$$

At the by-product works of the Newcastle and Gateshead Gas Company the methanol soda process is used.

The mixed crude benzole from the various works has a total sulphur content of 0.7%, of which 0.38% is sulphur as thiophene and 0.42% sulphur as carbon disulphide. Experimental work showed that to reduce the sulphur to that allowed by the National Benzole Company, 25 gall. of methanol and 100 lb. of flake caustic had to be used for each charge of 2,500 gall. crude benzole.

To the charge of crude benzole in the washer after the light acid treatment, 25 gall. of methanol and 100 lb. flake caustic are added, the washer then agitated for 6–8 hours. 100 gall. of water is then added and agitated for a further ½ hour. The xanthate solution is then run off to a receiver. Two successive washes of 50 gall. are then given and the washings added to the xanthate solution. The crude benzole is then distilled as usual. No material benefit was found by heating the benzole up to 100°F. during the treatment with methanol soda, but it was found in cold weather the reaction was retarded, and that the slight warming of the charge to 80°F. was very helpful.

Methanol of a suitable quality is recoverable from the xanthate. The process is, however, accompanied by such vile odours that it is impracticable to work.

The treatment of the xanthate solution may be carried out in an airtight lead-lined washer, fitted with an agitator and vent pipe leading to an oxide purifier for the removal of hydrogen sulphide from the gases evolved during the process.

A charge of xanthate is charged to the washer and sufficient sulphuric acid (diluted to 20% H_2SO_4) is run in to acidify the solution. After the reaction is completed the mixture is made just alkaline with caustic soda to remove hydrogen sulphide. The carbon disulphide is allowed to settle out, then run off from the bottom.

The neutralized solution, which contains about 15% methanol, is now fractionated. Methanol containing 95–98% methyl alcohol is easily obtained in one distillation, with only a small percentage of weak methanol for re-distillation.

The column used is 18 ft. high by 12 in. diameter filled with 1 in. Lessing ring. Dephlegmating and main condenser are provided and storage tanks for the strong and weak methanol.

Control of working is very easy, the percentage methanol in the distillate being calculated from the specific gravity.

The crude carbon disulphide obtained consists essentially of carbon disulphide and free sulphur, about 85% CS_2 being present. It is a black, evil-smelling liquid with a specific gravity of 1.30. In the laboratory a good quality of carbon disulphide was made by washing the crude carbon disulphide with strong sulphuric acid and caustic soda, then fractionating the washed product.

The removal of carbon disulphide from benzole by some chemical means is a matter of importance, particularly in view of the present tendency towards lower final sulphur content of coal gas. More or less complete extraction of benzole from the gas affords a convenient means of extracting more sulphur. This sulphur appears in the benzole as carbon disulphide, which, while not welcomed by the refiner, can be dealt with by the methods outlined above.

Thousands of gas consumers in Cork will benefit to the amount of £24,838 which is being returned to them by way of a rebate on the price of gas for the half-year ending June 30 last. A dividend of 6% per annum has been provided for. The balance of profit and loss after providing £2,000 for depreciation is £27,579. The Company's favourable position is due to money saved on direct shipments of coal. Frequently in the past coal had to be imported through Dublin, and this extra outlay raised the price of gas to consumers by almost 50%.

Perfecta Gas Thermostats, Ltd., have changed their name to Perfecta Gas Appliances, Ltd., and have removed to larger premises to cope with increased production requirements. They are now at 31–35, Belle Vue Road, Hendon, N.W. 4. (Telephone: Hendon 3810.)

Promoted by the Staff of Galashiels Gas Company, Ltd., a show and sale of garden produce has resulted in the substantial figure of £332 being raised for the Red Cross funds.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in the "Journal" should not be taken as an indication that they are necessarily available for export.

RECONSTRUCTION OF A SMALL GAS UNDERTAKING*

By DARRELL W. REES, M.B.E.

THIS is the story of a gas-works which, at the outbreak of war, had an output of approximately 70 million cu.ft. per annum. A policy of reconstruction had to be embarked upon, as the gas output in the winter months had increased from about 250,000 cu.ft. to 350,000 cu.ft. per day, due to increases in domestic sales, and also to a large consumption under contract at a certain premises. This consumption was as much as 100,000 cu.ft. per day.

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On receipt of tenders for this plant, I found that, owing to wartime conditions, costs were exceedingly high, and the period required for erection was very long, as there was difficulty in obtaining materials. I then learned that there was in Scotland a vertical retort setting of four downwardly heated fireclay vertical retorts, which was constructed in 1928, and had worked up until 1934, at which time the undertaking was absorbed by a larger concern, with the result that the plant became redundant. The plant, as it stood, was suitable for rebuilding, except that the refractory material could not be re-used, but the house and setting steel work were in very good condition. Having in mind the shortage of steel work and the difficulty in obtaining same owing to war conditions, my Directors decided to purchase this setting and rebuild it.

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For every size of works and every class of coal...

WEST'S

CARBONIZING PLANTS

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440 carbonizing plants have been built or are under construction by West's in 24 countries. Working results from a wide variety of gas coals have established the high efficiency and adaptability of the West systems.

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that the holder capacity would soon have been exhausted, and this on a Sunday morning would have happened in just over one hour.

We now had to turn our minds to the re-erection of a large gasholder, and when I brought out the new specification, I asked for a holder which was considerably heavier than the previous one, as the old holder threw only 6 in. W.G. when fully inflated, while the new one was to have a pressure of not less than 8½ in. W.G. inflated and 6 in. W.G. uncupped.

Every effort was made to patch up the retorts, as it was impossible to let down any for cold repairs, owing to the fact that with such a limited capacity for stocking gas, the amount of gas being made at peak loads was nearly equal to the amount of gas being sent out. However, everything that could be done was done, and although there were some very trying times during the next winter, when the gasholder was flat in the well, we did manage to carry on, and in fact not only for that winter, but for the winter of 1942/43 as well, as the holder which I anticipated would have been erected in twelve months at the outside, did in fact take two years to complete.

The next part of the works to receive my attention was the purifiers. This plant comprised four 16 ft. by 16 ft. by 6 ft. overhead boxes, without mechanical handling. The system of loading in operation was a hand-operated winch hauling the oxide in wicker baskets from yard level, which was then emptied into a barrow and wheeled along the top of the boxes to the one that was being filled. The whole operation took six men a day to complete.

I decided that some new system had to be put into operation, and after due consideration purchased a 15-ton per hour portable petrol driven belt loader. The length of the loader was 60 ft. between centres of belt and drums. This machine was purchased from Messrs. Frederick Parker, of Leicester. It was now possible with four men feeding the boot of this portable elevator to fill the purifier box in less than two hours, but this time was found to be too short for the men distributing in the box, so by using two men only at the bottom of the elevator, and one man inside the purifier box, the loading could be completed in approximately three hours. This meant a saving of over 40 man hours over the old system.

The discharging of the box was not difficult, as this was done through the bottom discharging door, but the oxide after it had been discharged had to be broken up and turned over for revivification, which, owing to the shortage of manpower, was difficult. The cost of the operation was so high, and, as previously mentioned, the shortage of labour was so acute that I decided to purchase a Coleman spent oxide disintegrator. This machine was direct coupled to an electric motor, and was portable, so that it could be wheeled under any of the boxes that were being discharged.

At first I discharged the oxide in the usual manner, but had a man underneath loading the large pieces into the oxide breaker by shovel. Then I thought of the possibility of fabricating some arrangement of chute, in order that the spent oxide may be discharged directly from the box into the machine. To save expense, as it was only an experiment, I used an old 18 in. steel chimney which was on the original Cochran boilers, and as this proved such a success I decided to fabricate an arrangement whereby the chute could be attached to the breaker and also allow it to be swivelled on its base, in order that the spent oxide may be evenly distributed on the purifier floor. This was a huge success, as the oxide was now broken up immediately and evenly distributed over the floor, and did not harden up.

The rest of the purifier plant was in quite good condition, with the exception of the drive to the centrifugal washer. On this plant there was a gas engine that had been there for some years, and was not running very efficiently. It was not thought the best thing to put an electric drive to this machine, as the electric supply as generated by the electric generating set was only intermittent. It would therefore have meant continuous running of the set to maintain a drive at the washer, so a small steam engine was put in instead of the gas engine, and this was also used to drive a Joseph Evans horizontal liquor pump, by means of a belt directly off the washer drive on to the fly-wheel of the pump, which meant a saving in the consumption of steam to the pump itself.

During the whole of this reconstruction I had been repeatedly inconvenienced by the fact that I had few facilities for making or reinstating machine parts.

There was already a good house which accommodated a sulphate of ammonia plant. This plant had been out of commission for some years, and it was not possible to put it back into anything like first-class condition. So I decided to scrap the plant, and take over the whole of the house and turn it into a fitting shop. As I had to purchase new machines, I decided to adopt the modern practice of having each machine self contained, with its own power unit. This eliminated shafting and belting.

In the new fitting shop I installed a 6-in centre back geared lathe, small electric drilling machine, taking up to ⅜ in. drills, a larger manual drilling machine, taking up to 1¼ in. drills, and another power operated drilling machine taking up to 2 in. drills. A hand operated pipe-screwing machine to screw pipes up to 3 in. has also been laid down, and a small blacksmith's forge, self contained, with its own electrically operated fan, and a new 8 in. by ¾ in. electric operated pedestal grindstone, which we use for tool sharpening. There is also a hand-operated plate and bar cutter, cutting plates up to ¼ in. and bars up to ⅜ in. The decision to fit out this shop has been amply repaid, and a considerable amount of material which would have previously been deemed unserviceable, and thrown away as scrap, can now be reinstated.

As well as the machines mentioned in the fitting shop, the Company also does its own oxy-acetylene welding and cutting, which has been almost indispensable; work of this nature is particularly difficult to get done unless you are in an area adjacent to industry.

Little now remained to put it into first-class condition, with the exception of the works offices, laboratory, and mess rooms. I decided to take over the whole top floor of the works offices and turn them into quarters for the workmen. A new mess room was made and hot-water circulating pipes were put up for clothes drying. I then made new washing accommodation, and fitted one of the other rooms with wash basins and shower bath; this, I was assured, was very much appreciated. I transferred the old manager's office into a laboratory, fitted it with new appliances, such as a Boys calorimeter and a Beasley recording calorimeter, gas analysis apparatus, specific gravity bell, G.L.C. muffle furnace, water sampling and testing apparatus, and new balance.

This made a comprehensive assortment of apparatus sufficient to carry out all routine gas-works tests.

I took over the old laboratory and turned it into an office and drawing office.

I am very pleased to say that the reconstruction of the works, particularly with regard to the carbonizing plant, has been fully justified.

National Gas Council

A meeting of the Central Executive Board of the National Gas Council was held on Sept. 14, at Gas Industry House. The Chair was taken by Mr. Frank H. Jones (Vice-Chairman).

A report on the general coal position was received. It was reported that a meeting of the District Coal Advisory Committees had been held in London on Sept. 9 to consider a letter from Lord Hyndley, the Controller-General, and the Board gave careful consideration to the proposals put before that meeting for dealing with the Coal situation during the forthcoming winter months.

Dr. Evans, Chairman of the Gas Advisory Committee, made a report with regard to the proceedings of the Committee, including the reference to a letter which he had addressed to the Chairmen of Gas Engineering Advisory Boards as to their functions with regard to the questions of coal and labour.

Sir David Milne-Watson, Chairman of the Council of the British Gas Federation, reported the proceedings that had taken place at meetings of the Council of the Federation held, respectively, on Aug. 11 and Sept. 13, 1943, in connexion with the Draft report of the Post-War Planning of the Gas Industry. Copies of this amended report were being prepared and would be sent to elected representative members of the National Bodies, with the suggestion that meetings of the District Executive Boards should be convened for giving further consideration to the matter.

The Board received a report with regard to the unsatisfactory position in connexion with the supply of new, and the repair of old, meters, and the question was referred to the Gas Advisory Committee, who were asked to take the matter up with the Ministry of Fuel and Power.

The next meeting of the Board will take place on Oct. 12.

Diary

Sept. 28.—B.C.G.A. at Gas Industry House: Publicity Committee 10 a.m.; Executive Committee, 2 p.m.

Sept. 30.—Institute of Fuel, Paper by R. Lessing, "Rational Preparation of Coal," Institution of Electrical Engineers, Savoy Place, W.C. 2, 5.30 p.m.

Sept. 30.—Association of Gas Corporations: 1.45 p.m., Finance Sub-Committee. 2 p.m., General Purposes Committee. 3 p.m., Council. Gas Industry House.

Oct. 2.—Yorkshire Junior Gas Association: Great Northern Hotel, Leeds, 2.30 p.m.

Oct. 6.—Southern Association of Gas Engineers and Managers (Eastern Section), Paper by Dean Chandler, entitled "Gas Flames, the Case for Aeration entirely at the Point of Combustion," Gas Industry House.

Oct. 7.—Illuminating Engineering Society (South Wales Area), Mackworth Hotel, Swansea, 5.30 p.m.

Oct. 11.—National Federation of Gas Coke Associations: General Committee (Special Meeting), 2.30 p.m., Gas Industry House.

Oct. 12.—National Federation of Gas Coke Associations: General Committee, 10 a.m., Gas Industry House.

Oct. 14.—Institute of Fuel, Annual Meeting and Luncheon, Connaught Rooms, Great Queen Street, W. 2.

Oct. 18.—Institute of Fuel (North-Eastern Section), Address by J. G. Bennett, Director B.C.U.R.A., Central Station Hotel, Newcastle-on-Tyne, 5.30 p.m.

Nov. 26.—Southern Association of Gas Engineers and Managers (Eastern Section), Paper by Dr. Weston and Dr. Haffner, entitled "New Evidence in regard to the Mechanism of Carbonization in Continuous Vertical Retorts," Gas Industry House.

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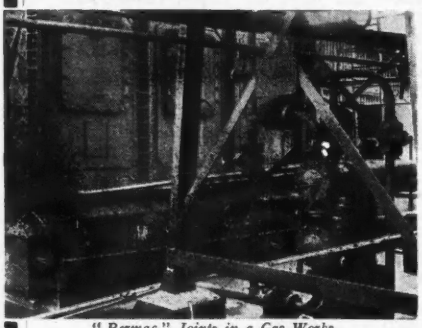

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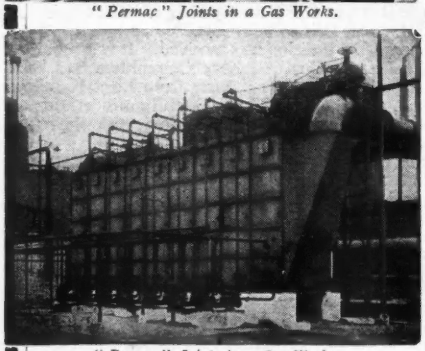

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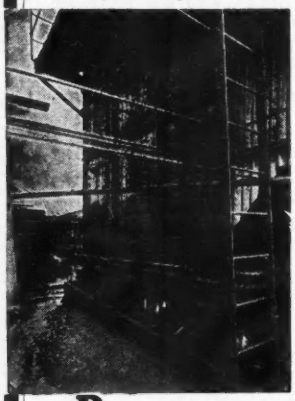

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Products Prices—Stocks and Shares

The London Market Sept. 20.

All Coal Tar Products are in good demand, and Pitch in the London area remains about 45s.

An Order entitled The Control of Toluene (No. 3) Order, 1943 (S. R. & O. 1943, No. 976), came into force on July 20, and introduced certain changes in the prices for different grades of Toluene.

There are no changes to report in the prices of Coal Tar Products.

The Provinces Sept. 20.

The average prices of gas-works products during the week were: Pitch and Crude Tar,* Toluole, naked, North, 90's, 1s. 11d., pure, 2s. 7½d. (controlled by the Control of Toluene No. 3 Order, 1943, dated July 14, operative from July 20, 1943). Naphtha and Xylole controlled by the Coal Tar Naphtha and Xylole Order, 1943, dated May 31 (S. R. & O., 1943, No. 768), operative from June 1. Carbolic acid, 60's, naphthalene, and anthracene controlled by the Coal Tar Products Prices Order S. R. & O. 2509, dated Dec. 7, 1942, and operative from Jan. 1, 1943. Filtered heavy oil (min. gr. 1,080), 7½d. to 8d. Creosote oil has been generally controlled as to direction and price for some time past. Current value—fuel grades 5d. to 5¼d.; timber preservation and other purposes 4¾d. to 6d.

* In regard to pitch and crude tar prices we would ask readers to refer to the editorial note on p. 396 of the "JOURNAL" for Sept. 10, 1941.

Tar Products in Scotland Sept. 18.

Market continues to be very satisfactory. Refined tar controlled. Value is 4½d. per gallon *ex* Works, naked. Creosote oil: Specification oil, 6½d. to 7d.; low gravity, 7¼d. to 7½d.; neutral oil, 6d. to 6½d.; hydrogenation oil, 5⅞d. per gallon; all *ex* Works in bulk. Refined cresylic acid is in good call at 3s. 6d. to 4s. 6d. per gallon *ex* Works, naked, according to quality. Crude naphtha: 6½d. to 7d. per gallon. Solvent naphtha: Basic prices delivered in bulk, 90/160 grade 2s. 8d., and 90/19 Heavy naphtha, Unrectified, 1s. 10½d. Rectified, 2s. 3d. per gallon. Pyridine: 90/160 grade, 13s., and 90/140 grade, 15s. per gallon.

At the opening last week stock markets were for the most part dull and uninteresting. Later, when the better news from Italy came in conditions became distinctly more cheerful. Small improvements took place among British Funds and home rails were also prominent—a feature being a big jump in Transport "C."

Business in the Gas Market showed no signs of any marked increase, although prices were in all cases maintained at the previous week's level, with here and there some small improvement in value. It will be noticed that Imperial Continental closed 3 points up and was changing hands up to 99—a price not reached since before the war. United Kingdom ordinary was also in demand and gained 9d. on the week.

The following quotations were changed during the week:

OFFICIAL LIST

Brighton Cons....	88—93	+1
British Ord. (x.d.)	107—112	Sept.
Croydon max. Div.	102—107	+2
Gas Light 3½ p.c. max.	77—80	—
Imperial Continental	97—100	+3
Severn Valley Ord. (x.d.)	20/9—21/9	Sept.
Ditto 4½ p.c. Cum. Pref. (x.d.) ...	20/—21/—	"
South-Eastern Gas Corporation Ord.	20/9—21/9	+/—
United Kingdom Gas Corporation Ord.	21/6—22/6	+/—
Ditto 3½ p.c. Red. Deb. (x.d.) ...	95—100	Sept.

SUPPLEMENTARY LIST

Eastbourne "B"	55—60	+1
Plymouth & Stonehouse 5 p.c. Deb. (x.d.)	112—117	Sept.

PROVINCIAL EXCHANGE

Bristol 5 p.c. max.	113½—115½	+1

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